

WHAT IS CLAIMED IS:

1 1. A process for manufacturing a high-strength, high-ductility alloy
2 carbon steel, said process comprising:

3 (a) forming a carbon steel alloy having a microstructure comprising laths of
4 martensite alternating with films of retained austenite, and

5 (b) cold working said carbon steel alloy to a reduction sufficient to achieve a
6 tensile strength of at least about 150 ksi.

1 2. A process in accordance with claim 1 in which step (b) comprises cold
2 working said carbon steel alloy to a reduction sufficient to achieve a tensile strength of from
3 about 150 ksi to about 500 ksi.

1 3. A process in accordance with claim 1 in which step (b) comprises cold
2 working said carbon steel alloy to a cross-sectional area reduction of at least about 20% per
3 pass.

1 4. A process in accordance with claim 1 in which step (b) comprises cold
2 working said steel alloy to a cross-sectional area reduction of at least about 25% per pass

1 5. A process in accordance with claim 1 in which step (b) comprises cold
2 working said carbon steel alloy to a cross-sectional area reduction of from about 25% to
3 about 50% per pass.

1 6. A process in accordance with claim 1 in which step (b) comprises cold
2 working said carbon steel alloy in a series of passes without heat treatment between passes.

1 7. A process in accordance with claim 1 in which step (b) is performed at
2 a temperature of about 100°C or below.

1 8. A process in accordance with claim 1 in which step (b) is performed
2 within approximately 25°C of ambient temperature.

1 9. A process in accordance with claim 1 in which said carbon steel alloy
2 is in the form of a rod or wire, and step (b) comprises drawing said carbon steel alloy through
3 a die.

1 **10.** A process in accordance with claim 1 in which said carbon steel alloy
2 is in the form of a sheet, and step (b) comprises rolling said carbon steel alloy.

1 **11.** A process in accordance with claim 1 in which step (a) comprises
2 (i) forming a carbon steel alloy composition having a martensite start
3 temperature of at least about 300°C,
4 (ii) heating said carbon steel alloy composition to a temperature sufficiently
5 high to cause austenitization thereof, to produce a homogeneous austenite phase with
6 all alloying elements in solution, and
7 (iii) cooling said homogeneous austenite phase through said martensite
8 transition range at a cooling rate sufficiently fast to achieve said microstructure
9 substantially avoiding carbide formation at interfaces between said laths of martensite
10 and said films of retained austenite.

1 **12.** A process in accordance with claim 11 in which said carbon steel alloy
2 composition having a martensite start temperature of at least about 350°C.

1 **13.** A process in accordance with claim 11 in which said retained austenite
2 films are of a uniform orientation.

1 **14.** A process in accordance with claim 11 in which said carbon steel alloy
2 composition consists of iron and alloying elements comprising from about 0.04% to about
3 0.12% carbon, from 0% to about 11% chromium, from 0% to about 2.0% manganese, and
4 from 0% to about 2.0% silicon, all by weight.

1 **15.** A process in accordance with claim 11 in which said temperature of
2 step (ii) is from about 800°C to about 1150°C.

1 **16.** A process in accordance with claim 1 in which step (a) comprises
2 (i) forming a carbon steel alloy composition having a martensite start
3 temperature of at least about 300°C,
4 (ii) heating said carbon steel alloy composition to a temperature sufficiently
5 high to cause austenitization thereof, to produce a homogeneous austenite phase with
6 all alloying elements in solution,

7 (iii) cooling said homogeneous austenite phase to transform a portion of said
8 austenite phase to ferrite crystals, thereby forming a two-phase microstructure
9 comprising ferrite crystals fused with austenite crystals, and

10 (iv) cooling said two-phase microstructure through said martensite transition
11 range under conditions causing conversion of said austenite crystals to a
12 microstructure containing laths of martensite alternating with films of retained
13 austenite.

1 17. A process in accordance with claim 16 in which step (iii) comprises
2 cooling said homogeneous austenite phase to a temperature of from about 800°C to about
3 1,000°C.

1 18. A process in accordance with claim 16 in which step (ii) comprises
2 heating said carbon steel alloy composition to a temperature of from about 1,050°C to about
3 1,170°C, and step (iii) comprises cooling said homogeneous austenite phase to a temperature
4 of from about 800°C to about 1,000°C.

1 19. A process in accordance with claim 16 in which said carbon steel alloy
2 composition consists of iron and alloying elements comprising from about 0.02% to about
3 0.14% carbon, from 0% to about 3.0% silicon, from 0% to about 1.5% manganese, and from
4 0% to about 1.5% aluminum, all by weight.